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RS320-2C

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NOTICE

This Instruction Manual provides general characteristics, operating procedures, theory of operation, maintenance and calibration procedures and includes a complete schematic, troubleshooting guide and parts list pages for the model(s) listed on the front cover.

Any questions concerning this documentation should be directed to the Publications Dept., Trygon Electronics, Inc., 1200 Shames Drive, Westbury, New York, 11590.

Questions concerning the operation and application of Trygon Power Supplies should be directed to the Applications Engineering Department, at the above address.

MEASUREMENT OF REGULATION AND RIPPLE

The specifications cited herein for regulation and ripple can be readily attained on every Trygon Power Supply, provided the proper method of measurement is employed. The major consideration is that the highly stable meter and oscilloscope, specified in the calibration section test procedures, must be connected to the sensing terminals and not the load terminals. The reason for this precaution is that the voltage drop between the load terminals and sensing terminals will yield an inaccurate regulation ripple measurement.

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SECTION I - DESCRIPTION

1.1 INTRODUCTION

The RS Series power supply is a flexible and dependable source of D. C. power which can be used to meet a variety of needs ranging in scope from inspection and production testing, to laboratory bench testing and systems applications.

The wide range of outputs available makes this unit well suited for use as a basic laboratory power source. The ability to provide power packaged in minimum space with high reliability meets the demands of most systems requirements.

All components used in the construction of the RS Series are of the highest quality available, and have been subjected to 100% incoming inspection at approved AQL sample levels.

Each electrolytic filter capacitor is of computer grade, and has been quoted by the manufacturer as having a life expectancy exceeding ten (10) years. All semiconductors are silicon for high temperature operation, and permit fully reliable operation at ambient temperatures up to 71°C without any derating, addition of heat sinks or forced air cooling. Each power transistor has been generously "derated" and temperature aged to provide high reliability. All rectifiers are hermetically sealed silicon types, and all zener diodes have been temperature stabilized.

1.2 GENERAL FEATURES

Output, Sensing, Remote Voltage Programming and Remote

1.2 GENERAL FEATURES (continued)

Current Programming terminals are located on terminal boards mounted on the rear panel of the unit. The power switch, power on indicator light, mode indicator light, current and voltage controls and appropriate metering devices are all located on the front panel. For convenience, additional output terminals have been provided on the front panel.

1.2.1 Constant Voltage Mode

A constant voltage is maintained across the output terminals at any pre-set value from zero to rated voltage output, provided that the load does not draw more than either the rated output current or more than the pre-set limiting current value determined by the front panel current control settings.

1.2.2 Constant Current Mode

Constant current operation is achieved by maintaining a constant voltage across an internal current sensing resistor. An automatic cross over network changes the mode of operation from Constant Voltage to Constant Current when the current demand reaches that of the pre-set current adjust control. The function of variations is load conditions. The crossover point is adjustable, and can be established anywhere within the current and voltage range of the unit.

1.2.3 Automatic Current Limiting

Short circuit protection is provided by the Automatic Current Limiting circuit which limits the maximum output current under all load conditions. The point at which automatic current limiting occurs is variable, and may be selected anywhere from 1% of the rated current to the full rated current output of the unit. In the event of a short circuit, the output voltage drops to zero, and returns to normal only when the short circuit is

1.2.3 Automatic Current Limiting (continued)

removed.

1.2.4 Mode Indicator

A front panel mode indicator light indicates when the unit is operating in either the constant current or current limiting mode of operation.

1.2.5 Automatic Overvoltage Protection (Optional Feature)

Automatic Overvoltage (OV) Protection is available as an option wherein special circuitry automatically tracks the programmed output voltage and prevents it from exceeding this output voltage. The voltage differential that will cause the OV to trip is approximately 5% or 1.5 volts above the programmed voltage. Minimum OV trip point is approximately 5 volts.

1.2.6 Remote Programming

Remote Programming is provided in both the voltage and current modes of operation. Both voltage and current may be remotely programmed over their entire ranges. The scale factor for Remote Voltage Programming is shown in Table 2-2. The Remote Current Programming is approximately determined by computing the value of the programming resistor using the formula $RPGM = 100 \left(1 - \frac{\text{Load Current}}{\text{Rated Current}}\right)$.

1.3 PRECAUTIONARY MEASURES

1.3.1 Wire Size

To assure proper regulation under all load conditions, and to prevent severe distortions of the AC line voltage, it is very important to take into consideration the physical size and current handling capabilities of the input power line. Serious losses in regulation and an increase in ripple may result from

1.3.1 Wire Size (continued)

under rated or over loaded AC input lines. The maximum AC impedance from the breaker box to the power supply input should not exceed 0.75 ohms. See Table 2-1 for recommended wire sizes.

1.3.2 Voltage Regulator and Inverter Inputs

Do not use voltage regulators or inverters as a primary power source. The outputs of these devices are usually not sinusoidal in nature, and if used as the AC source for the power supply, will cause serious loss of regulation of the power supply output. Capacitive input filtering used for semiconductor power supplies requires charging to the peak of the rectified AC wave which non-sinusoidal AC sources cannot provide.

1.3.3 Variable Transformer Input

If a variable transformer is to be used to test the power supply for low and high AC line operation, it must be able to supply at least twice the VA requirements of the power supply and load.

1.3.4 Systems Considerations

In systems applications it is recommended that each power supply input power line by run separately to the AC distribution box, in order to minimize cross coupling and interaction between equipment. Do not run sensitive signal leads such as the remote sensing leads in the same cable as the AC input without shielding. It is strongly recommended that the AC input cables should not be run in close proximity to the output load cable leads, if minimum ripple is desired.

1.3.5 Terminal Post Resistance

All terminals and shorting links serving Outputs, Sensing and Programming must be securely tightened before use. Serious

1.3.5 Terminal Post Resistance (continued)

loss of regulation and an increase in ripple can result due to a voltage drop caused by loose terminals and shorting links.

1.4 SPECIFICATIONS

Electrical and physical specifications for this unit appear on the Specification sheet which is included in this manual.

SECTION II - INSTALLATION & OPERATION

2.1 MECHANICAL INSTALLATION

2.1.1 Rack Mounting

Any standard EIA relay rack will accommodate the RS Series power supplies in only 3 1/2 inches of vertical mounting space. Mounting of the unit is easily accomplished by inserting four mounting screws through the slotted holes provided in the four corners of the front panel of the power supply, and on into the matching threaded holes of the relay rack.

2.1.2 Bench Use

Though designed primarily as a rack mounting unit, the RS Series power supply may be operated in a bench type configuration as well. It is therefore fully enclosed in a protective metal case, and equipped with rubber mounting feet which serve to protect the unit and the surface upon which it rests from scratching, and to provide an airflow channel under the unit for ventilation purposes.

2.2 ELECTRICAL CONNECTIONS

2.2.1 AC Input

The unit is supplied with a heavy duty 3 wire line cord equipped with molded plug and ground strap to provide a path for AC input power.

The power handling ability of the AC power lines feeding AC power to the line cord must be considered, as serious losses

2.2.1 AC Input (continued)

in regulation and substantial increases in ripple can occur as a result of insufficient power handling capacity of these lines. The AC impedance from the breaker box to the power supply input connector should not exceed 0.75 ohms. Any movable electric contact surface (such as the wiper arm of a variable transformer) should be kept clear of impedance producing oxide coatings.

Care should be exercised in selecting the proper wire size for the AC input lines. The figures listed in Table 2-1 will serve as a guide in making this selection.

TABLE 2-1 - AC INPUT WIRE SIZE

Length of Run (Single Lead)	Wire Size (AWG Standards)
10 feet or less	16
10 feet to 20 feet	14
20 feet to 50 feet	12
50 feet to 100 feet	10

2.2.2 Barrier Strips

Two barrier strips mounted on the rear panel provide output, sensing and remote programming connections. See data sheet provided following page 1-5 for outline drawing and barrier strip designations.

2.2.3 DC Output

DC output voltage is available at both front and rear panel locations, and may be sensed (monitored) either at the output terminals of the power supply (Local Sensing) or at the load itself (Remote Sensing).

2.2.4 Local Sensing

Local sensing of the output voltage may be made at the rear panel output terminals. The shorting links must be placed across rear panel terminals -V and -S and terminals +S and +V.

2.2.5 Remote Sensing

Remote sensing of the output voltage is available only if the load is connected to the rear panel output terminals. The shorting links between rear panel terminals -V and -S and terminals +S and +V must be removed, and separate sensing leads installed between sensing terminals -S and +S and the load.

2.2.6 Local Programming

Local programming of either current or voltage is available by shorting the appropriate rear panel terminals. For local current programming operation, a shorting link should be placed across barrier strip terminals 1 and 2 (RIP). For local voltage programming operation, a shorting link should be placed across barrier strip terminals 4 and 5 (RVP). In both local current programming and local voltage programming operation, the output amplitude is dependent upon the setting of the appropriate front panel adjustment control.

2.2.7 Remote Programming

Remote programming of both voltage and current may be achieved by removing the shorting link from the appropriate barrier strip terminals and substituting a remotely operated adjustment control resistance in its place.

In the remote voltage programming mode of operation, the scale factor required for the remotely operated voltage adjustment control is as shown in Table 2-2. In order for this remotely

2.2.7 Remote Programming (continued)

operated adjustment control to function properly, front panel VOLTAGE ADJUST control must be set fully CCW. Operation of this power supply without either shorting link or remotely operated adjustment control connected across remote voltage programming barrier strip terminals 4 and 5 (RVP), will result in an unregulated output voltage.

The required size of the remote current programming resistor may be determined by use of the formula $Rpgm = 100 \left(1 - \frac{\text{Load Current}}{\text{Rated Current}}\right)$, where Rpgm is the remote program resistor, load current refers to the desired output current, and rated current refers to the maximum output current of the unit. To pbtain proper operation of the remotely controlled current adjust control, it is necessary that front panel CURRENT ADJUST control be set fully CW. Operation of this power supply without either shorting link or remotely adjusted current programming control connected across remote current programming barrier strip terminals 1 and 2 (RIP) will result in a complete loss of output current.

2.2.8 Shorting Links

The unit is shipped with shorting links in place across terminals 1 and 2, 4 and 5, -S and -V, and +S and +V of the barrier strips. In this configuration, local programming and sensing is available at the barrier strip terminals. Table 2-3 lists the various shorting link connections and their functions.

2.2.8 Shorting Links (continued)

TABLE 2-2 - REMOTE VOLTAGE PROGRAMMING FACTORS		
Model	Voltage Range	RVP SCALE FACTOR Ohms/Volt
RS20-20B	0-20V	100
RS40-15B	0-40V	125
RS60-12B	0-60V	83.3
RS160-4B	0-160V	312.5
RS320-2C	0-320V	312.5

TABLE 2-3 - SHORTING LINK APPLICATION		
Terminals	Condition	Function
-S and -V +S and +V	Shorted	Local sensing and regulation at rear panel output terminals
-S and -V +S and +V	Ext. Sense Leads	Remote sensing and regulation at load
4 and 5	Shorted	Voltage programmed locally, output dependent upon voltage adjust pots
4 and 5	Ext. PGM res.	Voltage programmed remotely, output dependent upon size of PGM resistor
1 and 2	Shorted	Current programmed locally, output dependent upon current adjust pots.
1 and 2	Ext. PGM res.	Current programmed remotely, output dependent upon size of PGM resistor.

2.3 CONTROLS

2.3.1 Front Panel

TABLE 2-4 - FRONT PANEL CONTROLS

Symbol	Name	Function
S1	AC POWER	Power switch, controls input power
R66 (R56 on 'C' Version)	VOLTAGE ADJUST	10 Turn Potentiometer, adjusts voltage output
R12 (R77 on 'C' Version)	CURRENT ADJUST	10 Turn Potentiometer, adjusts current

2.3.2 Internal

All internal control settings have been factory pre-set, and require no additional adjusting. However, if it should become necessary to adjust any of the internal controls due to circuit changes caused by component aging or replacement, refer to the calibration section of this instruction manual.

2.4 OPERATION

2.4.1 Control Settings

Set all front panel controls fully CW so that unit will operate in the Voltage rather than Current Limiting mode.

2.4.2 Shorting Links

If Local Sensing rather than Remote Sensing operation is desired, ascertain that shorting links are in place across the appropriate terminals.

2.4.3 Grounding

Either side of the Output may be grounded, or the Output

2.4.3 Grounding (continued)

may be used in a floating condition.

2.4.4 Power On

Connect the power supply to a suitable source of 115 VAC, 60 cycle power. Set POWER switch S1 to AC-ON, and observe that pilot lamp DS1 glows.

2.4.5 Warm-Up

No warm-up time is necessary to place the unit into operation. However, a 30 minute warm-up period is recommended to reach rated stability.

2.4.6 Series Operation

To operate two or more power supplies in a series configuration, connect the output of each power supply in series. When operating in this mode, it is necessary to adjust the output of each unit independently. The output voltage is equal to the sum of the voltage settings of each power supply.

2.4.7 Parallel Operation

A) With rated resistive load connected across the output of power supply A as shown in Figure 2-2A, set VOLTAGE ADJUST control to desired output voltage, and set CURRENT ADJUST control for maximum rated output current.

B) Connect power supply B as shown in Figure 2-2B. With no load across the output, set VOLTAGE ADJUST control for an output voltage 2 volts higher than the output voltage of power supply A. Place a short across the output terminals, and set the CURRENT ADJUST control for 1/2 the total load current requirement.

C) Remove all former output loads and connect the outputs of power supplies A and B in parallel with each other, and

2.4.7 Parallel Operation (continued)

in parallel with the load, as shown in Figure 2-3.

D) If parallel operation of these two power supplies is desired for a systems application, it is important that both units be turned on simultaneously. It is therefore recommended that both power supplies be connected to a single large circuit breaker. Maximum output current will be twice that of either of the two power supplies, while minimum output current will be that of power supply B, or half the total load current.

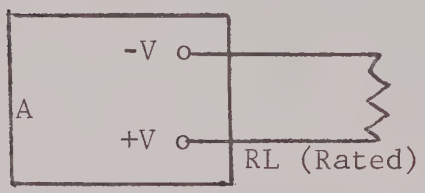


FIGURE 2-2A

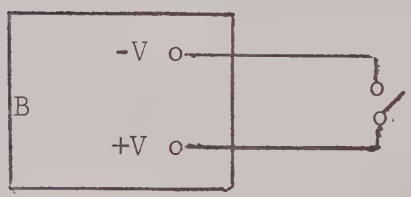


FIGURE 2-2B

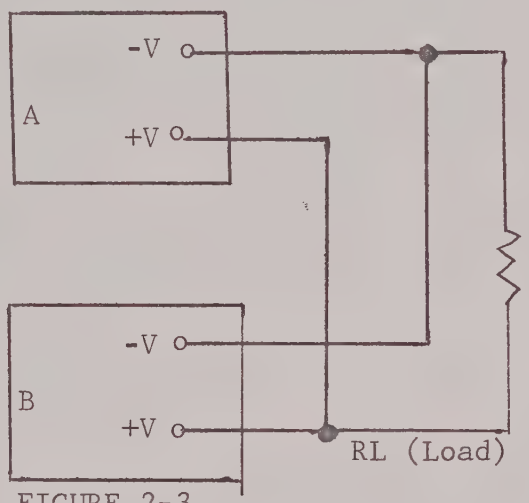


FIGURE 2-3

NOTE: If parallel operation of Trygon power supplies utilizing Overvoltage (OV) Protection is desired, consult the factory for special instructions.

SECTION III - THEORY OF OPERATION

3.1 GENERAL - (Note that circuit references applicable to the RS320- 2C are shown in parenthesis if different than the lower voltage models.)

The purpose of the RS Series power supplies is to transform and rectify the AC input into a well-regulated, stable and adjustable DC output. The following paragraphs describe the major circuits used in the power supplies. As each circuit is described, reference should be made to both the Block Diagram, Figure 3-1 and the Schematic Diagram in the rear of this manual.

3.1.1 Primary Input

Input power is obtained through power transformer T1 (T1, T2) and full wave silicon diode rectifiers. Each pair of rectifiers provide the necessary DC voltages to the various sections of the unit.

When AC power switch S1 is set to AC-ON, AC pilot lamp DS1 glows, and AC power is applied to the power transformers. Regulated DC output power is immediately available from the power supply.

3.1.2 Reference Supply

The recitified and filtered voltage from rectifiers CR1 and CR2 and filter capacitor C1 is pre-regulated by Coarse Reference Regulator zener CR13 (CR3). This provides a stabilized DC voltage to Constant Current Source Q2, whose output is regulated by Precision Voltage Reference zener CR14 (CR4). Constant Current Source Q1 controls the drive to Q2 and in turn is controlled

3.1.2 Reference Supply (continued)

by Q2. The voltages developed across Constant Current Source References CR14 (CR4) and CR15 (CR16) are highly stable reference voltages established at a higher positive potential than the positive output of the main supply.

3.1.3 Pre-Regulator

The purpose of the Pre-Regulator section is to maintain the unregulated input voltage on Input Filter Capacitor C8 (C22) at a suitable value compared to the output voltage in order to control the power dissipated the Series Regulator.

The method used to accomplish this is to "fire" a pair of SCR's (silicon controlled rectifiers), CR9 (CR27) and CR10 (CR28) at controlled points along the input sine wave to increase or decrease the potential to which the input filter capacitor may charge. The SCR's are "fired" (allowed to pass current) by the application of a positive pulse at the junction of gating resistors R35 (R57) and R37 (R58) from amplifier Q25 (Q11), which amplifies the triggering pulse from unijunction transistor Q12 (Q13). The unijunction transistor triggers the SCR's when charged sufficiently by timing capacitor C13 (C10) to cause conduction. The SCR's are turned off with each alternate half cycle of the input sine wave.

3.1.4 Series Regulator

The pre-regulated DC voltage from the SCR's is directed through the Series Pass transistors. The conduction of these transistors is controlled by circuitry which causes them to act as variable resistors. Their overall resistance varies in accordance with the need of the power supply to increase or decrease its output voltage or current.

3.1.4 Series Regulator (continued)

The Series Pass transistors are controlled by several driver stages which amplify signals from the error amplifier.

3.1.5 Comparator and Error Amplifier

The voltage sensing and comparison is accomplished by differential amplifiers Q10 (Q9) and Q11 (Q10). A sample of the output voltage on the base of Q11 (Q10) is compared to the stable reference voltage on the base of comparator Q10 (Q9). An unbalance caused by a change in voltage adjustment control R66 (R56) will appear as a voltage change in the collector of Q11 (Q10).

This difference voltage is amplified by error amplifier Q7 (Q6), and is used to regulate the Series Pass transistors via the Series Pass drivers. Error amplifier Q7 (Q6) has two diode inputs to its base which form an OR gate for error signals. CR19 (CR7) supplies error signals from the comparator, and CR18 (CR6) supplies an error signal in the event of a short circuit, or if the power supply is driven into the current limiting mode of operation.

When operating in the current limiting mode, differential amplifier Q3 and Q4 become balanced, causing diode CR18 (CR6) to conduct, and in turn drives error amplifier Q7 (Q6) toward cut-off. This signal also causes Q8 (Q7) to conduct, thereby causing current mode indicator lamp DS2 to glow.

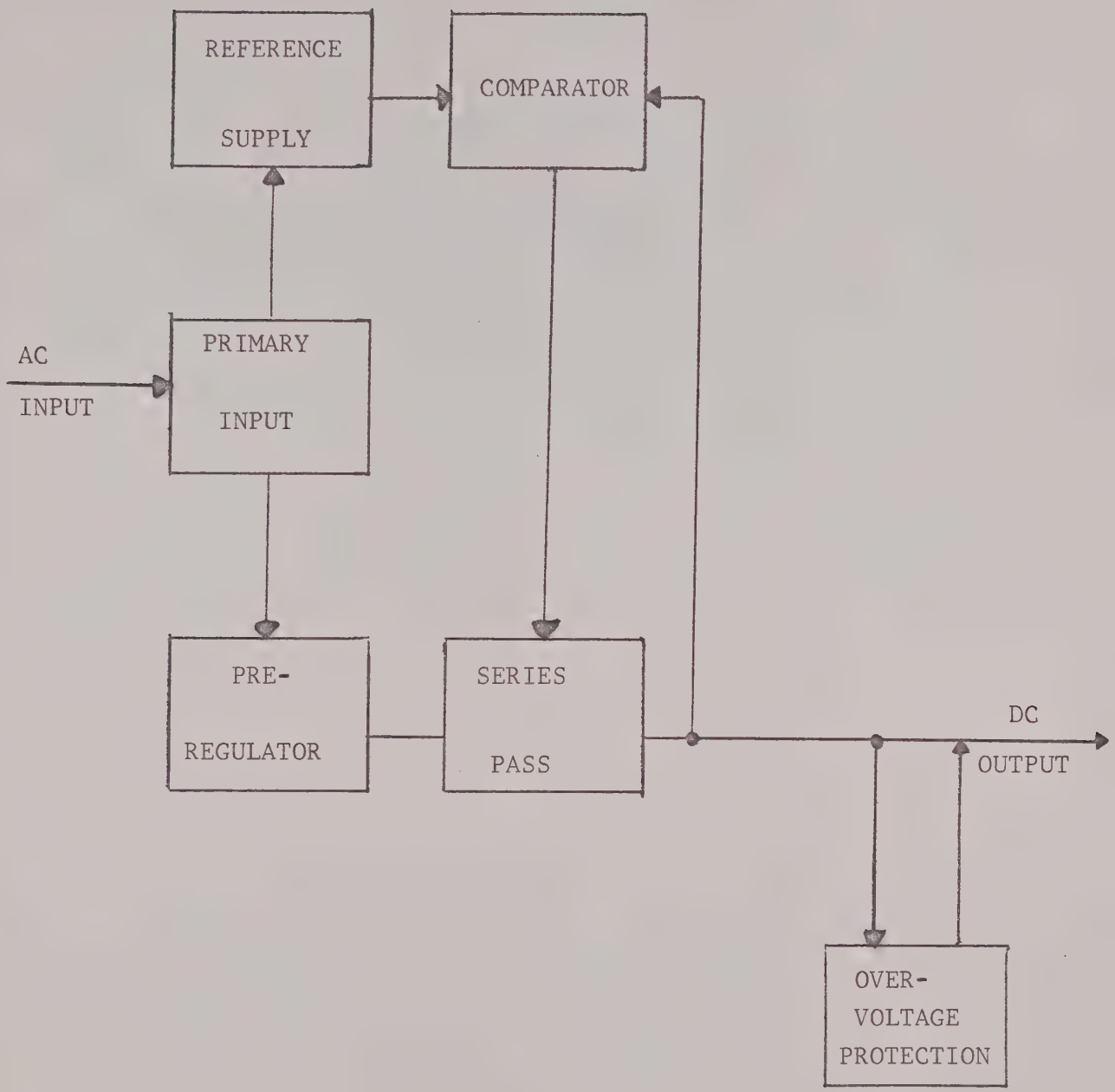


FIGURE 3-1 - BLOCK DIAGRAM

SECTION IV - MAINTENANCE

- WARNING -

HIGH VOLTAGES ARE PRESENT
USE CAUTION

4.1 GENERAL

This power supply is a precision instrument. It is strongly recommended that only experienced troubleshooting personnel perform troubleshooting operations or attempt to repair the unit. If the power supply appears to be malfunctioning at all, the following procedure is recommended for isolating possible defects.

4.2 LOADS AND INTERCONNECTIONS

1) Disconnect all loads and interconnections.

2) Connect a resistive load across the output terminals, and operate the unit to determine whether the fault lies within the unit or extermally. Observe that shorting links are in place across terminals 1 and 2, 4 and 5, -V and -S and +V and +S, and that all connections are tightly made.

4.3 TROUBLESHOOTING

1) Set the VOLTAGE ADJUST controls fully CW. Use a 20,000 ohms per volt voltmeter or digital voltmeter to check the schematic located in the rear of the manual. Any reading which is grossly incorrect indicates that the stage being tested or the one immediately preceding it, is defective. The Block Diagram, Schematic Diagram and appropriate sections of the Theory of Operation will prove helpful in any troubleshooting work. Proper

polarity to be observed when testing can be easily obtained from the Schematic Diagram.

2) If voltage checks show no deviations from the prescribed values, disconnect AC power and proceed with point to point resistance checks across pots, switches, diodes, resistors, transistors, in that order.

3) When the trouble is of an intermittent nature such as poor regulation, ripple, etc., the use of an oscilloscope to determine dynamic changes will be necessary.

SECTION IV - CALIBRATION

5.1 GENERAL

The following adjustments should be made when necessary to assure optimum operating characteristics and maximum efficiency of the power supply.

5.2 TEST EQUIPMENT REQUIRED (or equivalent)

A) Oscilloscope, Tektronix Type 561

B) Differential Amplifier Plug In, Tektronix Type 63

C) Time Base Plub In, Tektronix Type 67

D) Digital Multimeter Systron Donner Model 7004A

E) Variable Auto transformer, Powerstat Type 3PN136

5.2.1 Shorting Link Application

For test purposes, shorting links should be connected across terminals 1 and 2, 4 and 5, -V and -S and +V and +S, to provide local sensing and local programming. To reduce pick up, shielded wire must be used for all connections between test equipment and the power supply being tested. To prevent ground loops, it is important that only one ground connection be made, as shown in Figure 5-1 and Figure 5-2. Tighten all terminal connections as securely as possible, and set all front panel controls fully CW.

5.3 CALIBRATION PROCEDURE -- (Please refer to the sentence in parenthesis on top of page 3-1.)

5.3.1 Voltage Adjust Control

A) Maximum Voltage

Set front panel VOLTAGE ADJUST control fully CW. Adjust Maximum Voltage control R67 (R24) to obtain an output voltage 0.5 VDC

5.3.1 Voltage Adjust Control (continued)

in excess of the maximum rated output voltage.

5.3.2 Current Adjust Controls

A) Maximum Current

Connect a test ammeter having a full scale current indicating capacity of 150% that of the rated current output across the output terminals of the power supply. (Set all front panel controls fully CCW). Apply power to the unit under test and slowly rotate CURRENT control fully CW. Observe that the maximum current obtainable is approximately 110% that of the maximum rated current output. If it is not possible to achieve 110% of the maximum rated current output, adjust Maximum Current control R6 (72) until that value is attained. Set AC Power Switch to OFF.

Connect a suitable load resistance across the output terminal connections. The load resistance must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Set AC Power Switch to ON. Note the voltage indicated on the Digital Multimeter. Disconnect the resistive load from the output and observe the voltage indicated on the Digital Multimeter. The maximum change in output voltage should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

If it is not possible to maintain the load regulation as stated in the preceding paragraph, readjust Maximum Current control R6 (R72) slightly and recheck the load regulation.

5.3.2 Current Adjust Controls (continued)

B) Minimum Current

With no load on power supply, set the VOLTAGE ADJUST control to maximum (CW) and CURRENT ADJUST control to minimum (CCW). Adjust R11 (R80) until the voltmeter indicates a collapse. Turn CURRENT ADJUST control slightly CW Voltage should come back up with only this slight rotation. If it requires too much rotation then readjust R11 (R80) again. This should put the minimum current adjust setting at approximately 1% of maximum rating.

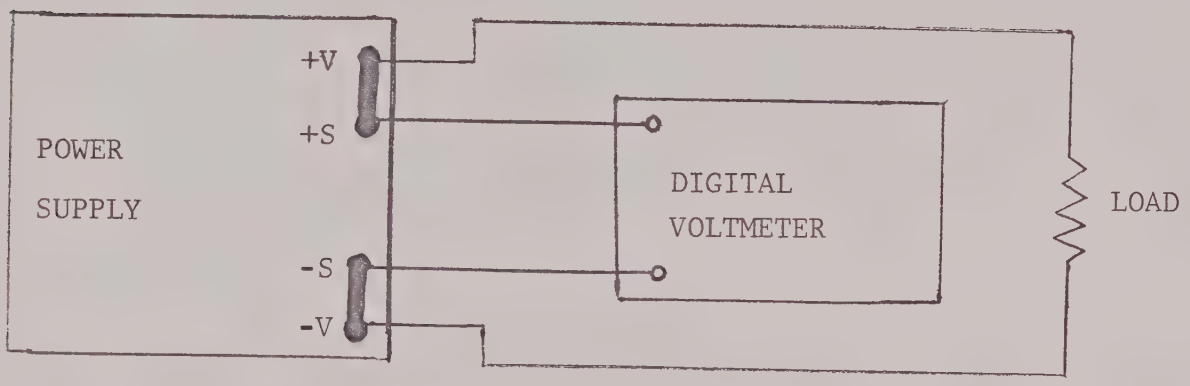


FIGURE 5 - 1

CONSTANT VOLTAGE OPERATION

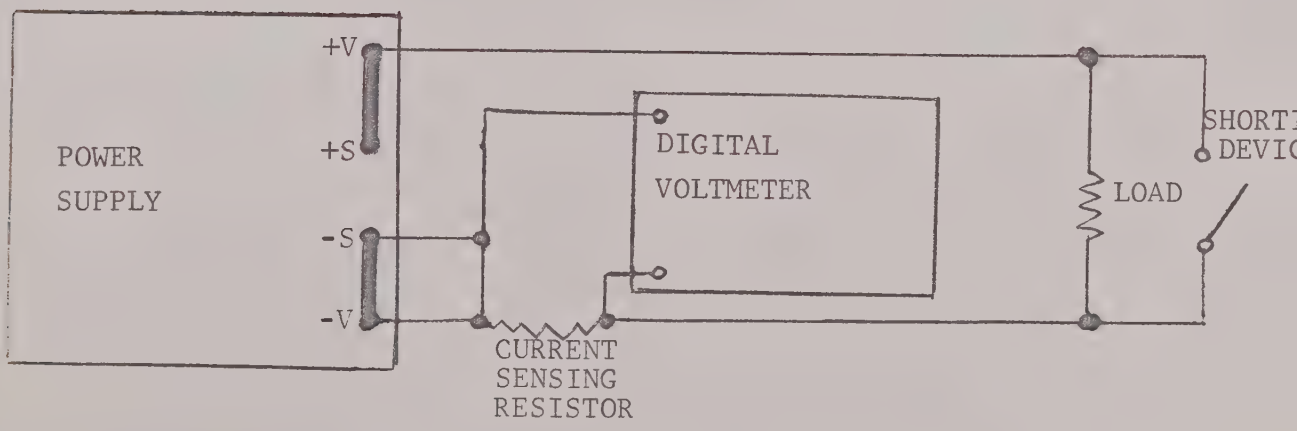


FIGURE 5 - 2

CONSTANT CURRENT OPERATION

5.3.3 Constant Voltage Operation

A) Load Regulation

With the equipment connected as shown in Figure 5-1, connect a suitable load resistance across the Output terminal connections. The load resistance selected must be able to dissipate the rated power of the unit (P = IE) and must be of sufficient value to yield the rated output current when the rated voltage is applied. Note the voltage indicated on the Digital Multimeter. Disconnect the resistive load from the output. The maximum change in output DC voltage indicated on the Digital Multimeter should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage indicated with the load resistance applied across the output terminals.

B) Line Regulation

Place the resistive load across the output and note the voltage indicated on the Digital Multimeter. (Vary the input line voltage $\pm$ 10 percent. The maximum change in output voltage should not exceed by more than 0.01% or 3mv (whichever is greater) that of the output voltage measured at either extreme of the AC input.

C) Ripple Voltage

In order to reduce pickup, schielded test leads should be used in making ripple measurements. With the resistive load connected across the output terminals, measure the AC ripple with the Digital Multimeter. Vary the AC input power 10% above and below the nominal AC input level. The maximum ripple amplitude should not exceed 0.5 mv RMS.

5.3.4 Constant Current Operation

A) Load Regulation

With the equipment turned off, disconnect the resistive load from the output terminals. Connect a small current sensing resistor in series with the resistive load and then connect the load back across the output terminals. Selection of the proper value for the current sensing resistor may be easily made using the formula $RS = \frac{I}{IR}$ where RS = Value of Current Sensing Resistor and IR = Rated Load Current. Connect the equipment as shown in Figure 5-2, and apply power to the power supply.

Vary the VOLTAGE ADJUST control and resistive output load as necessary, to achieve rated current and voltage output. Decrease the load resistance until current meter reading exceeds full scale indication. Rotate CURRENT ADJUST control CCW to return the current meter reading to full scale. Observe that the output voltage has decreased from its previous full scale reading, and that increasing the VOLTAGE ADJUST control has no effect upon the output voltage or current. This indicates that the unit is now operating in the Constant Current Mode.

Measure the voltage across the small sensing resistor. Compute and note the current flow through this resistor. Change the output load from the resistive load previously used, to a short. Again measure the voltage across the small sensing resistor and compute the value of the current flow through this resistor. The change in current should not exceed by more than 0.5% the rated current previously noted with a full resistive load across the output.

5.3.4 Constant Current Operation (continued)

B) Line Regulation

Replace the resistive load across the output and measure the voltage drop across the small sensing resistor. Compute and note the current flow ($I = \frac{E}{R}$) through this resistor.

Vary the input line voltage $\pm$ 10 percent.

Note the maximum change in voltage across the senging resistor and compute the maximum current flow. The maximum change in current should not exceed by more than 0.5% the rated current previously noted at either extreme of the AC input.

C) Ripple Current

With the AC input line voltage adjusted to the nominal AC input voltage and the resistive load connected across the output, measure the amplitude of the AC ripple as seen across the sensing resistor with the Digital Multimeter. Compute and note the current flow. Vary the AC input line voltage $\pm$ 10 percent. Measure the maximum voltage drop and compute the maximum current flow. The maximum ripple current must not exceed by nore than 0.25% or 5 ma (whichever is greater) that of the current flow noted during nominal input line voltage.

MANUFACTURER'S CODE LISTING - ELECTRICAL PARTS

1) The numbers designated in the SPARES column of the following ELECTRICAL PARTS LISTING indicate the recommended spare parts requirement for support of this equipment for a period of one year.

2) The code designations listed in the MFR column of the ELECTRICAL PARTS LISTING have been assigned to the following manufacturers:

CODE	MANUFACTURER
A-B	ALLEN BRADLEY
ARN	ARNOLD
BUSS	BUSS
CARL	CARLING
CD	CORNELL DUBILIER
CLAR	CLAROSTAT
CORN	CORNISH
CTS	CHICAGO TELEPHONE SUPPLY
ERIE	ERIE
GE	GENERAL ELECTRIC
GI	GENERAL INSTRUMENTS
HOYT	HOYT
IREC	INTERNATIONAL RECTIFIER CORP.
IRES	INTERNATIONAL RESISTOR CORP.
OHM	OHMITE
SCHW	SCHWEBER

CODE	MANUFACTURER
LEE	LEECRAFT
MILW	MILWAUKEE
MOTO	MOTOROLA
PHAO	PHAOSTRON
RCA	RADIO CORPORATION OF AMERICA
ROT	ROTRON
SAGE	SAGE
SANG	SANGAMO
SPRA	SPRAGUE
STEV	STEVENS
TRAN	TRANSITRON
TRY	TRYGON
UNI	UNITRODE
WILG	WILGREEN
WL	WARD LEONARD
SEMC	SEMCOR

Semi-conductors commonly used in Trygon Power Supplies are available for replacement or spare parts use under the following Trygon, commercial manufacturer or JEDEC part number.

TRANSISTORS

SEMI-CONDUCTOR PART NUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUIVALENT
700000	See 705067	
700001	See 700002	
700002	700002	2N3638A
700010	TR346	2N1556
700020	See 705067	
700030	TR361	2N652
700040	TR375	2N1533
700047	700047	2N4238
700050	700050	2N657A
700070	TR951	2N2527
700080	700080	2N3055
700083	700083	2N3232
700085	700085	2N3442
700115	See 705067	
700120	700120	2N1530
700130	700130	2N1554
700140	700140	2N1560
700160	700160	2N2140
700180	700180	2N2714
700182	700182	2N3566
700191	700191	2N4912
700195	700195	2N3441
700196	700196	2N4912
700197	700197	2N3738
700200	700200	2N2139
700205	700205	2N3440
700400	700400	2N3441
700401	700401	2N3771
700402	700402	2N3772
700410	700410	2N3442
700412	700412	2N3568
700413	700413	2N3644
700415	700415	2N3585
700417	700417	2N4918
700420	700420	2N3584
700429	DTS411	DTS411
700430	DTS413	DTS413
700431	DTS423	DTS423
700502	700502	2N5037
700508	700508	2N5240
705018	705018	2N3416
705067	705067	2N2905A
705068	705068	2N2219A
705069	705069	2N4340
705070	705070	2N3233
705071	705071	2N3447
720145	UJ25	2N2647

Semi-conductors commonly used in Trygon power supplies are available for replacement of spare parts use under the following Trygon, commercial manufacturer of JEDEC part number.

RECTIFIERS

SEMI-CONDUCTOR PART NUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUIVALENT
705014	705014	2N1929
720000	C35B	2N685
720005	C33F	
720010	C35F	2N682
720015	C30F	
720030	C50AX258	
720040	C50B	2N1913
720043	C50C	2N1915
720050	C50F	2N1910
720053	C60A	2N2025
720060	E016	
720075	E0130	
720110	SV515	IN823
720131	720131	IN3618
720132	720132	IN3616
720133	720133	IN3619
720135	720135	IN3495R
720136	720136	IN3621
720137	720137	IN3622
720173	IN759A	IN5242B
720175	IN746A	IN5226B
720181	IN751A	IN5231B
720182	IN754A	IN5235B
720185	IN752A	IN5232B
720192	IN753A	IN5234B
720196	IN755A	IN5236B
720241	IN1360A	IN2986A
720262	IN2163A	IN2163A
720263	IN2163A	IN2163A
720273	SCR285-2	
720274	SCR285-3	
720275	SCR285-4	
720277	SCR285-5	
720280	SCR93-2	
720290	SCR93-3	2N2573
720300	SCR93-4	2N2574
720301	SCR93-5	2N2677
720303	SCR93-7	
720330	70H10	
720335	40HF10	1N1184A
720350	70H20	1N4130
720383	IN4585	1N4585
720384	1N4384	1N4384
720387	1N4740A	1N4740A
720388	1N4733A	1N4733A
720394	1N964B	1N5243B
720395	1N965B	1N5245B

Semi-conductors commonly used in Trygon power supplies are available for replacement of spare parts use under the following Trygon, commercial manufacturer or JEDEC part number

RECTIFIERS

SEMI-CONDUCTOR PART NUMBERS

TRYGON STOCK NO.	TRYGON or MFR P/N	JEDEC EQUIVALENT
720427	See 720136	
720440	TR4148	1N148
720443		1N3208
720450	See 720456	1N3659
720453	See 720456	1N4719
720454	MR1031A	1N4720
720455	MR1032A	1N4721
720456	MR1034A	1N4722
720458	See 720456	
720459	1N758	1N758
720397	1N2164A	1N2164A
720460	1N961B	1N5240B
720468	1N968	1N5250B
720473	1N821	1N821
720488	60HF60	1N2138
720489	C46E	
725008	C180A	
725019	1N765A	1N5241B
725056	MR1220SL	
725071	1N3515A	1N5236B
725076	1N3616	1N3616
725077		1N3262R
725079	MCR2835-4	
725081	MCR216R-2	
725082	MCR216R-3	
725083	MCR216R-5	
725085	MCR216R-6	
725087	MCR3918-1	2N5168
725138	725138	2N4441
725139	See 725142	
725140	MAC 3-2	
725142	725142	2N4442
725143	Y0525	
725144	40526	
741001	741001	2N4990

L E C T R I C A L P A R T S L I S T -- PS32D-2C

FERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK-N
C 1	CAP 950MF 50V 500 1154 03	00835	DRWG	820051
C 2	CAP .0047 250V		MKT1813	800147
C 4	CAP .00033MF 600V CK62AW332	33498	GP332K	800025
C 5	CAP .001MF-600V	33498	GP102M	800006
C 6	CAP .01 MF 600V 811Z5V103P	33498	ACOM GP103P	800090
C 7	CAP 1MF 250V	24138	CM	800185
C 8	CAP 10MF 50V TTXF	90210	TTX106N050A0LIP	810010
C 9	CAP 75MF 15V 400756F015DD4	00835	556	810090
C 10	CAP 1MF 250V	24138	CM	800195
C 11	CAP .22 MF 400V METAL MYLAR		MKT1813	800254
C 12	CAP .47 MF 400V METAL MYLA		MKT1813	800295
C 13	CAP 35MF 25V 400356F025DD4	00853	556	810060
C 14	CAP 750MF 350V 86F228S FF	99392	DRWG	820035
C 17	CAP .047MF-400V		TYPE CM	800155
C 20	CAP .22MF400V		MKT1813	800254
C 22	CAP 2200MF 400V 86F239S GH	99392	DRWG	820138
C 23	CAP .47MF-400V		MKT1813	800295
C 24	CAP .0047MF-600V	33498	GP472M	800050
C 27	CAP 210MF 25V 6000217G025DJ4	03508	TGF	810161
C 28	CAP 90ME 400V 86F232S BA	99392	DRWG	820027
C 30	CAP.22 F400V METAL MYLAR		MKT1813	800254
C 31	CAP .0047MF-600V	33498	GP472M	800050

E L E C T R I C A L P A R T S L I S T -- PS320-2C

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
C 32	CAP 0.1MF 250V	24138 CM		800185
CR 1	DIODE 1N4004	21845	1N4004	710384
CR 2	DIODE 1N4004	21845	1N4004	710384
CR 3	ZENER DIODE IN 1360A	C 81483	1N1360A	720241
CR 4	DIODE 1N751A	81483	1N751A	720181
CR 5	DIODE 1N4004	21845	1N4004	710384
CR 6	DIODE 1N4004	21845	1N4004	710384
CR 7	DIODE 1N4004	21845	1N4004	710384
CR 8	DIODE 1N4004	21845	1N4004	710384
CR 9	DIODE 1N4004	21845	1N4004	710384
CR 10	DIODE 1N4004	21845	1N4004	710384
CR 11	DIODE 1N4004	21845	1N4004	710384
CR 12	DIODE 1N4004	21845	1N4004	710384
CR 13	DIODE 1N4004	21845	1N4004	710384
CR 14	DIODE 1N4004	21845	1N4004	710384
CR 15	DIODE 1N4004	21845	1N4004	710384
CR 16	DIODE ZENER IN 2164A	D 04713	1N2164A	720397
CR 17	DIODE ZENER IN964B	C 81483	1N964B	720394
CR 18	DIODE 1N4004	21845	1N4004	710384
CR 19	DIODE 1N4004	21845	1N4004	710384
CR 20	DIODE 1N4004	21845	1N4004	710384
CR 21	DIODE ZENER IN 4585	05828	1N4585	720383

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK
CR 22	DIODE ZENER IN 4585	05828	1N4585	72038
CR 23	DIODE 1N4004	21845	1N4004	71038
CR 24	DIODE 1N4004	21845	1N4004	71038
CR 25	DIODE 1N1206A-1N3622	81483	1N1206A	72013
CR 26	DIODE 1N1206A-1N3622	81483	1N1206A	72013
CR 27	SCR 2N3670	18722	2N3670	72513
CR 28	SCR 2N3670	18722	2N3670	72513
CR 29	DIODE ZENER IN 968	81483	1N9689	72041
CR 30	DIODE 1N4004	21845	1N4004	71038
CR 31	DIODE 1N4733A	04713	1N4733A	72038
CR 32	DIODE 1N1206A-1N3622	81483	1N1206A	72013
CR 33	DIODE 1N5401	*	1N5401	71048
CR 36	DIODE 1N4004	21845	1N4004	71038
CR 37	DIODE 1N4004	21845	1N4004	71038
CR 38	DIODE ZENER IN 4585	05828	1N4585	72038
CR 39	DIODE ZENER IN 4585	05828	1N4585	72038
CR 40	DIODE ZENER IN 4585	05828	1N4585	72038
CR 41	DIODE ZENER IN 4585	05828	1N4585	72038
CR 42	DIODE 1N4004	21845	1N4004	71038
DS 1	PILOT LIGHT 55RH F2 R1 NISL	91802	104D032	77000
DS 2	LIGHT IND 41N G6 1317 985T	91802	219DA87	77003
F 1	FUSE 15A-MDA-250V	75915	MDA	87003

E L E C T R I C A L P A R T S L I S T -- RS320-2C

REFERENCE		COMPONENT	MFR	MFR PART NUMBER	STOCK #
M	1	METER 350V MS2T	33005	MS2T	752095
M	2	METER 2A-EXT-MS2T	33005	MS2T	750015
Q	1	TRANS 2N3440-SPEC	30045	DRWG	700265
Q	2	TRANS MM4001	04713	MM4001	705066
Q	3	TRANS 2N2714	03508	2N2714	700180
Q	4	TRANS 2N2714	03508	2N2714	700180
Q	5	TRANS 2N2714	03508	2N2714	700180
Q	6	TRANS 2N2905A	04713	2N2905	705067
Q	7	TRANS 2N2714	03508	2N2714	700180
Q	8	TRANS 2N2714	03508	2N2714	700180
Q	9	TRANS 2N2714	03508	2N2714	700180
Q	10	TRANS 2N2714	03508	2N2714	700180
Q	11	2N 4238	04713	2N4238	705047
Q	12	TRANS 2N2905A	04713	2N2905	705067
Q	13	UNIJUNCTION UJ25 4JX5E600	03508	UJ25	720145
Q	14	TRANS 2N2905A	04713	2N2905	705067
Q	15	TRANSISTOR DTS 423	Q	DTS423	700431
Q	16	TRANS DTS 423		DTS423	700431
Q	18	TRANSISTOR TR1591	30045	DRWG	700191
Q	20	TRANS 2N2219A-SPEC	05828	2N2219A	705068
Q	21	TRANS 2N2714	03508	2N2714	700180
R	1	RWW 150 25 W 2D		CR25	650570

E L E C T R I C A L P A R T S L I S T -- RS32D-2C

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 2	RMF D108 K 85 W 2	RL2D	12400 RC2D	620610
R 3	RMF D49892 K 85 W 85	CECTD	12126 M1/2TI	620710
R 4	RMF 1618 K 85 W 1	CECT	12126 M1/2TI	620380
R 5	RESISTOR 17D 1		KM100	630261
R 6	RMF 1896 K 85 W 1	CECT	12126 M1 1/2 TI	620402
R 7	RMF 1896 K 85 W 1	CECT	12126 M1 1/2 TI	620402
R 8	RCOMP1008 85 W108	RC2	D1121 RC2D	610070
R 9	RMF 75D 85 W 1	CECT	12126 M1/2TI	620250
R 1D	RMF 1896 K 85 W 1	CECT	12126 M1 1/2 TI	620402
R 11	RCOMP4708 85 W108	RC2	D1121 RCR2D	610140
R 12	RCOMP 487 K 85 W1D	RC2D	D1121 RC2D	610250
R 13	RCOMP 33D 85W		D1121 RC2D	610120
R 14	RCOMP 108 K 85 W1D	RC2	D1121 RC2D	610290
R 15	RMF 75K .5W 1%		12126 M1/2TI	620754
R 16	RCOMP5608 85 W108	RC2	D1121 RCR2D	610150
R 17	RMF 4D2 85 W 1	CECT	12126 M1/2TI	620140
R 18	RLTC 185K 1W 3 1000S		83025 1000S	630418
R 19	RLTC 75D 1W 3 1000S	D	83125 1000S	630372
R 2D	RMF 1896 K 85 W 1	CECT	12126 M1 1/2 TI	620402
R 21	RMF 1896 K 85 W 1	CECT	12126 M1 1/2 TI	620402
R 22	RMF 1.74K .5W 1		12126 M1/2TI	620389
R 23	RMF 75D 85 W 1	CECT	12126 M1/2TI	620250

ELECTRICAL PARTS LIST -- RS320-2C

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 24	POT 500-1.5W-110	11236	DRWG 099030-5	600146
R 25	RLTC 750-3W-3%	83125	1300S	630375
R 27	POT 500-1.5W-110	11236	DRWG 099030-5	600146
R 28	RCOMP1008 85 W10 RC2	01121	RC20	610070
R 29	POT 5 K 185 W20 110 D	11236	DRWG 099030-10	600290
R 30	RCOMP 487M 85 W10 RC20	01121	RCR20	611135
R 31	RCOMP 330 K 85 W10 RC20	01121	RCR20	610600
R 32	RLTC 38 K 38 W 38 1300	83025	1300S	630460
R 33	RWW 1 K 2 W10 RWW	12400	RWH	640500
R 34	RLTC 38 K 38 W 38 1300	83025	1300S	630460
R 35	RWW 828 28 W108 RW	12400	RWH	640325
R 36	RCOMP1508 85 W108 RC2	01121	RCR20	610080
R 37	RCOMP1508 85 W108 RC2	01121	RCR20	610080
R 38	RCOMP 2.2K-.5W-10%	01121	RC20	610210
R 39	RMF 681 5W 1%	12126	M1/2T1	620220
R 40	RMF 2895 K 85 W 85 CECT	12126	M1/2T1	620467
R 41	RCOMP 330 85W	01121	RC20	610120
R 42	POT 258 K 825W10 UPE2000	11236	UPE200RE	600364
R 43	RMF 4899 K 85 W 1 CECT	12126	M1/2T1	620580
R 44	POT 258 K 825W10 UPE2000	11236	UPE200RE	600364
R 45	RMF 4899 K 85 W 1 CECT	12126	M1/2T1	620580
R 46	RMF 4899 K 85 W 1 CECT	12126	M1/2T1	620580

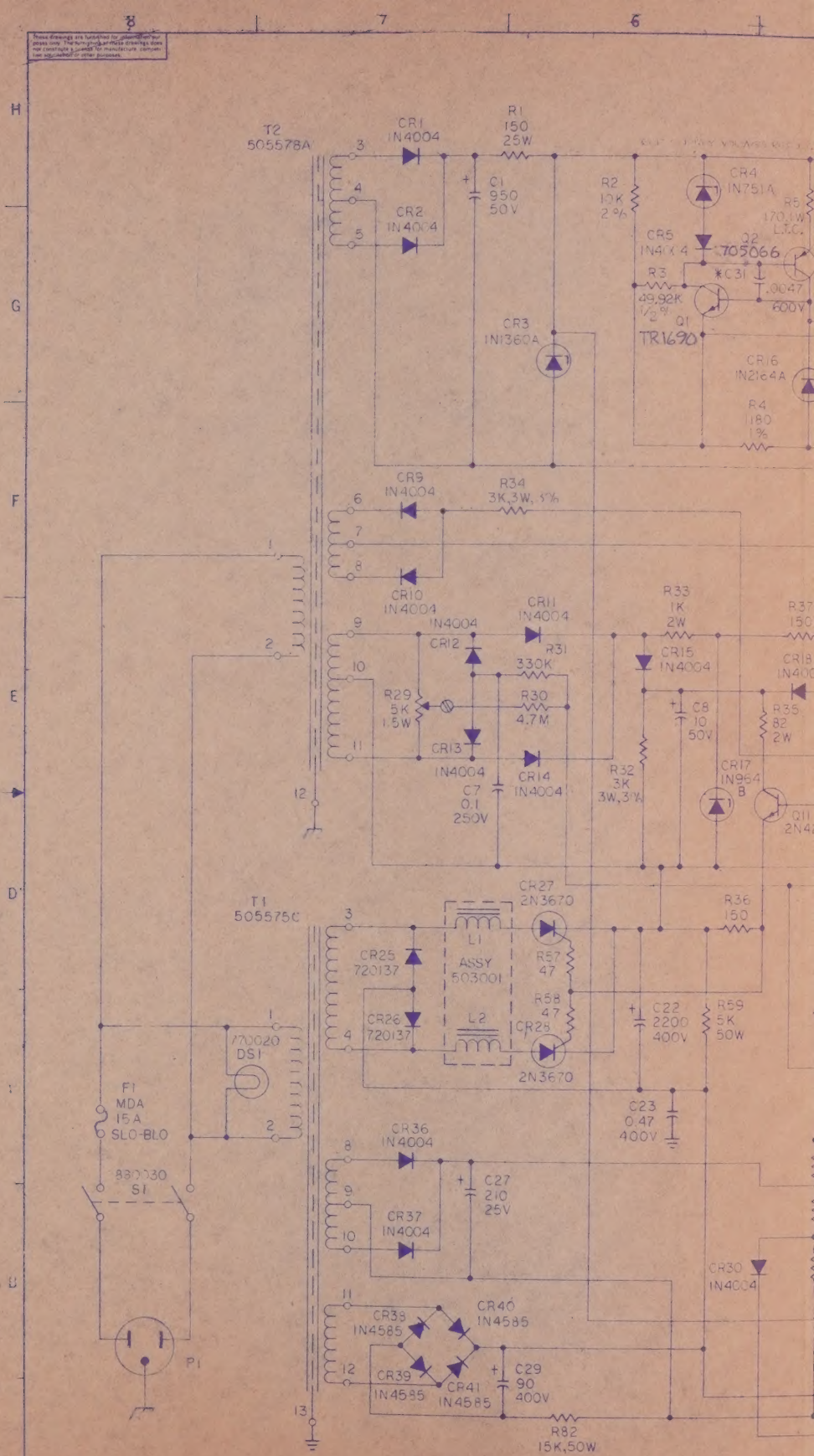
ELECTRICAL PARTS LIST -- PS320-2C

REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 47	RCOMP 1M-.5W-10%	01121	RC20	611040
R 48	RMF 100Ω K 85 W 1B CECT	12126	M5T1	620800
R 49	RMF 100Ω K 85 W 1B CECT	12126	M5T1	620800
R 50	RMF 3081 K R5 W 1 CECTO	12126	M1/2T1	620677
R 51	RCOMP100Ω 85 W10Ω RC2	01121	RC20	610070
R 52	RWW 30K 5W 5 5X	VAL5		640650
R 53	RCOMP100Ω 85 W10Ω RC2	01121	RC20	610070
R 54	RCOMP 15Ω K 85 W10 RC2	01121	RCR20	610300
R 56	POT 100K 2W 10TURN	32997	3540-S-1-104	600455
R 57	RCOMP 47Ω 85 W10Ω RC2	01121	RCR20	610030
R 58	RCOMP 47Ω 85 W10Ω RC2	01121	RCR20	610030
R 59	RWW 5K 50W 5 4D	FR50		650304
R 61	R COMP 1K R5W	01121	RC20	610100
R 62	RWW 5K 5W 5 5X	12697	VC5E	640551
R 63	R COMP 1K R5W	01121	RC20	610100
R 64	RWW 9K 5W 5 5X	24681	VAL5	640549
R 65	PLTC R7 38 W 38 1300	83125	1300S	630020
R 66	PLTC R7 38 W 38 1300	83125	1300S	630020
R 67	R COMP 1K R5W	01121	RC20	610100
R 68	RCOMP 2.2K-.5W-10%	01121	RC20	610210
R 70	RMF 10Ω 85 W 1 CECT	12126	M1/2T1	620030
R 71	RMF 27Ω-.5W-1%	12126	M1/2T1	620095

ELECTRICAL PARTS LIST -- R5320-2C

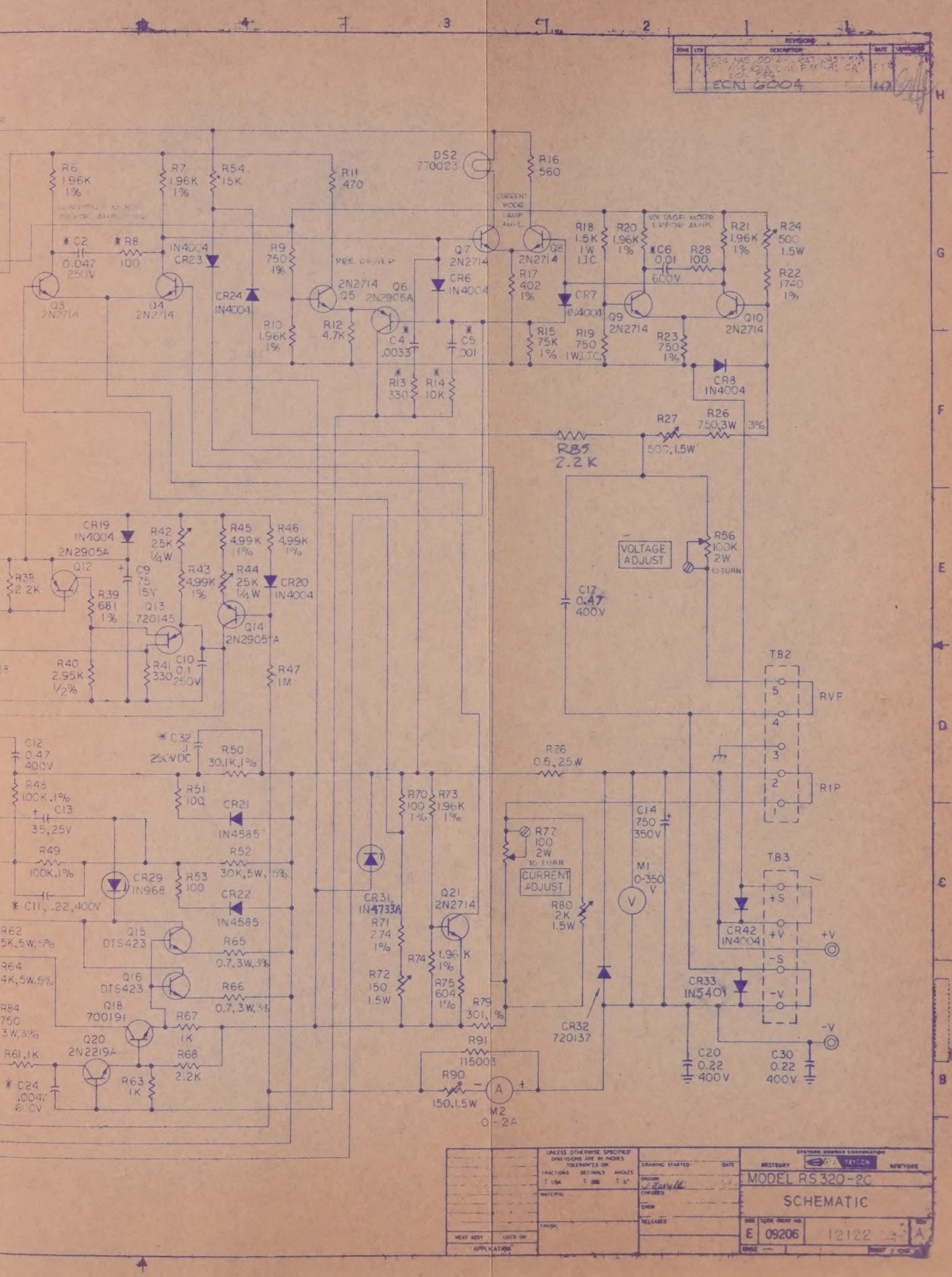
REFERENCE	COMPONENT	MFR	MFR PART NUMBER	STOCK #
R 72	POT 150 1.5W 110	11236	DRWG 099030-3	600071
R 73	RMF 1896 K 85 W 1 CECT	12126	M1 1/2 T1	620402
R 74	RMF 1896 K 85 W 1 CECT	12126	M1 1/2 T1	620402
* R 75	RMF 604 85 W 1 CECT	12126	M1/2TI	620210
R 76	RWW .5-25W-2D		FR25	650081
R 77	POT 100 2W 10 TURN	32997	3540-S-1-101	600043
R 79	RMF 301-.5W-1%	12126	M1/2TI	620110
R 80	POT 2K 185 W20 110	0 11236	DRWG	600204
R 82	RWW 15K 50W 5%		FR50	650818
R 84	RLIC 750-3W-3%	83125	1300S	630375
R 85	RCOMP 2.2K-.5W-10%	01121	RC20	610210
R 90	POT 150 1.5W 20	11236	DRWG	600070
R 91	SHUNT 2AMP	09206	DRWG	115003
R 92	RCOMP 22-.5W-10%	01121	RC20	610012
S 1	SWITCH DPST NS152K	73559	20K50-73XG182	88C030
TB 2	STRIP BARRIER 670Y 7	75382	670Y7	851107
TB 3	OUTPUT BLOCK	R76460	19998 DRWG	075468

* ANY GOOD COMMERCIAL GRADE ELECTRICAL EQUIVALENT WHICH IS READILY AVAILABLE MAY BE USED.



NOTES

1. UNLESS OTHERWISE SPECIFIED: ALL RESISTORS ARE IN OHMS, 1/2W, 10%. ALL CAPACITORS ARE IN MICROFARADS.
2. * DENOTES SELECT AT TEST.


REVISIONS
ECN 6004
R6 1.96K 1%
R7 1.96K 1%
R54 15K
R11 470
DS2 770023
R16 560
CURRENT MODE ERROR AMPL
VOLTAGE MODE ERROR AMPL
R18 1.5K 1W LIC
R20 1.96K 1%
R21 1.96K 1%
R24 500 1.5W
R22 1740 1%
*C2 0.047 250V
*R8 100
IN4004 CR23
R9 750 1%
Q7 2N2714
Q8 2N2714
*C6 0.01 600V
R28 100
Q3 2N2714
Q4 2N2714
CR24 IN4004
2N2714 Q5
Q6 2N2906A
CR6 IN4004
R17 402 1%
CR7 IN4004
R10 1.96K 1%
R12 4.7K
*C4 .0033
*C5 .001
R15 75K 1%
R19 750 1W LIC
Q9 2N2714
Q10 2N2714
R23 750 1%
*R13 330
*R14 10K
CR8 IN4004
R27 500, 1.5W
R26 750 3W 3%
R85 2.2K
CR19 IN4004
2N2905A
R42 25K 1/4W
R45 4.99K 1%
R46 4.99K 1%
R38 2.2K
Q12
C9 75 15V
R43 4.99K 1%
R44 25K 1/4W
CR20 IN4004
R39 681 1%
Q13 720145
Q14 2N2905A
VOLTAGE ADJUST
R56 100K 2W 10-TURN
C17 0.47 400V
R40 2.95K 1/2%
R41 330
C10 0.1 250V
R47 1M
TB2
5
4
3
2
1
RVP
RIP
C12 0.47 400V
*C32 250VDC
R50 30.1K, 1%
R76 0.5, 25W
R48 100K, 1%
R51 100
CR21 IN4585
R70 100 1%
R73 1.96K 1%
C13 35, 25V
R49 100K, 1%
R52 30K, 5W, 5%
R77 100 2W 10-TURN
CURRENT ADJUST
C14 750 350V
M1 0-350 V
TB3
CR29 IN968
R53 100
CR22 IN4585
CR31 IN4733A
Q21 2N2714
R80 2K 1.5W
+S
CR42 IN4004
+V
-S
-V
*C11, .22, 400V
Q15 DTS423
R65 0.7, 3W, 5%
R71 2.74 1%
R74 1.96K 1%
R72 150 1.5W
R75 604 1%
R79 301, 1%
CR33 IN5401
Q16 DTS423
R66 0.7, 3W, 5%
Q18 700191
R67 1K
CR32 720137
R91 11500
R90 150, 1.5W
M2 0-2A
Q20 2N2219A
R68 2.2K
R61 1K
R63 1K
*C24 .0047 600V
C20 0.22 400V
C30 0.22 400V
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES
DRAWING STARTED DATE
DRAWN L. Farrell
CHECKED
ENGR
RELEASED
MATERIAL
FINISH
NEXT ASSY USED ON APPLICATION
SYSTRON DONNER CORPORATION
WESTBURY TRYGON NEWYORK
MODEL RS 320-2C
SCHEMATIC
SIZE E
TOOL ORDER NO. 09206
DWG NO. 12122
REV A
SHEET 1 OF 1

MP MASTER
MA31204